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January 7, 2008

## MEMORANDUM

**TO:** Council Members

**FROM:** Jeff King, Senior Resource Analyst

**SUBJECT:** Report on the status of the Wind Integration Action Plan

Work has been underway for more than two years on most of the sixteen actions set forth in the March 2007 Wind Integration Action Plan (WIAP). A meeting of the Policy Steering Committee of the Wind Integration Forum was held on December 2, 2008, to review the status of the actions called for in the WIAP and to provide recommendations regarding the future of the Wind Integration Forum and continued work on wind integration issues. The status report accompanying this memo was provided to the members of the Policy Steering Committee prior to the December meeting.

Staff will brief the Council regarding the status of the WIAP and will summarize key discussions that occurred at the Policy Steering Committee meeting. Staff will note continuing and follow-on actions involving Council staff and several that may be desirable to include in the action plan of the Sixth Power Plan. Because the Steering Committee has not yet formally endorsed a plan for the continuation of the WIAP, a conclusive set of follow-on actions will be presented at a future Council Meeting. One Council-related action, however, that appears to enjoy the full support of the Steering Committee is the extension of the charter of the Wind Integration Forum. The Forum is chartered through April 2009 as an advisory Committee to the Council. Staff plans to bring a proposal to extend the charter of the Wind Integration Forum to the Council at its March meeting.

# Northwest Wind Integration Forum

## Status Report to the Policy Steering Committee

November 2008

The Northwest Wind Integration Action Plan (Action Plan), adopted in March 2007, was developed to address the operational and infrastructure issues associated with large-scale wind energy development in the Pacific Northwest and to define actions that Northwest parties could undertake to help the region meet its wind energy objectives in a reliable, least-cost fashion. The purpose of this report is to review the status of the 16 actions identified in the Action Plan. The motivation and objective of each action is briefly described. Progress, findings and conclusions to date are reviewed and needed follow-up actions are identified. In the course of preparing the report, we have also evaluated whether any of the original recommendations need to be revised or eliminated in light of new information. Possible continuing roles of the Steering Committee are set forth at the conclusion of the paper.

### **Adoption of the action plan and subsequent developments**

Development of the Northwest Wind Integration Action Plan was co-sponsored by the Northwest Power and Conservation Council (Council) and the Bonneville Power Administration (BPA). A Steering Committee drawn from the energy leadership of the Pacific Northwest guided the activities of a Technical Work Group that was divided into five sub-committees addressing various aspects of the issue. The Action Plan identified 16 Actions, grouped broadly into analytical, operational and transmission infrastructure categories. Subsequent to the release of the Action Plan, the Northwest Wind Integration Forum (the Forum) was chartered as an advisory committee of the Northwest Power and Conservation Council. There have been several follow-up meetings of the Technical Work Group and one meeting of the Steering Committee since the release of the Action Plan in March 2007.

A significant amount of effort has been put into implementing the Action Plan, but there is more work to be done. Several of the Action Items are complete. Others are progressing, or have advanced to the point where needed follow-on actions have been identified. Initial progress on several actions faltered because of institutional or resource limitations or lack of explicit responsibility. And alas, work has yet to begin on several actions. With the accelerating pace of wind development and increasing operating experience with wind energy by Northwest utilities, there is agreement regarding the need for the region to redouble its efforts to implement the Action Plan.

We note as well that since the release of the Action Plan, there has been a significant increase in awareness of the transmission and operational issues related to wind integration among federal and state regulators as well as calls for greater collaboration on the topic among utilities and policymakers across the western United States. Increasingly, efforts to support wind integration in the Northwest need to be seen in the broader context of efforts underway by the Western Governor's Association, the Western Electric Industry Leaders Group (WEIL), the Committee for Regional Electric Power Cooperation (CREPC) and the Western Electricity Coordinating Council (WECC).

As of October 2008, committed (operating and under construction) wind capacity in the four Northwest states stands at about 3000 MW. This capacity is allocated to balancing authorities as shown in Figure 1.

As is evident in the figure, the majority of Northwest wind capacity (60%) is interconnected to the BPA balancing authority, with smaller but significant amounts interconnected to PacifiCorp West, Puget Sound Energy and NorthWestern Energy. Figure 2 represents the output of the capacity shown in Figure 1 by type of utility customer. BPA, though integrating most of the regional wind capacity, acquires relatively little of the output for its own customers.

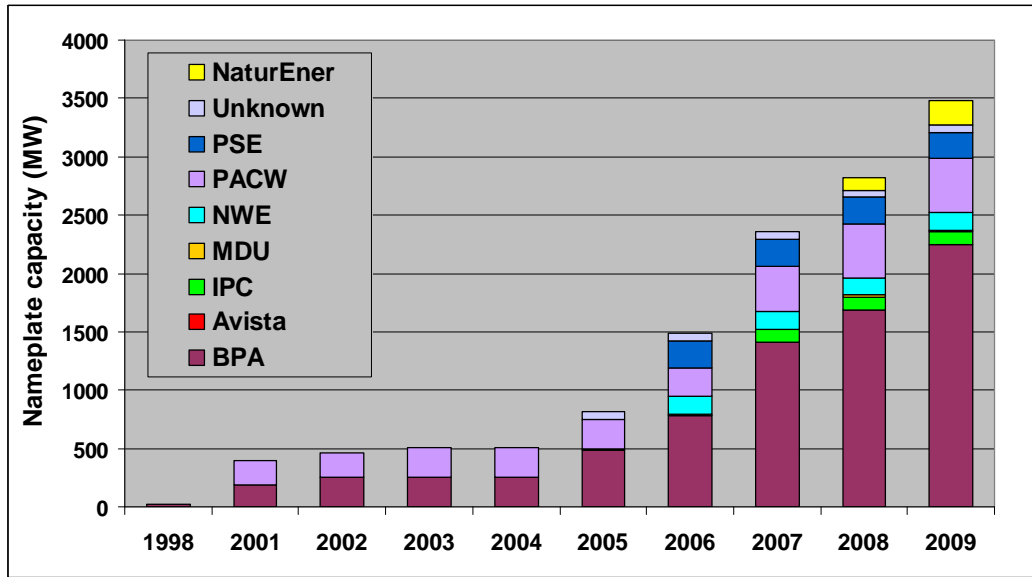


Figure 1: Northwest wind capacity by balancing authority

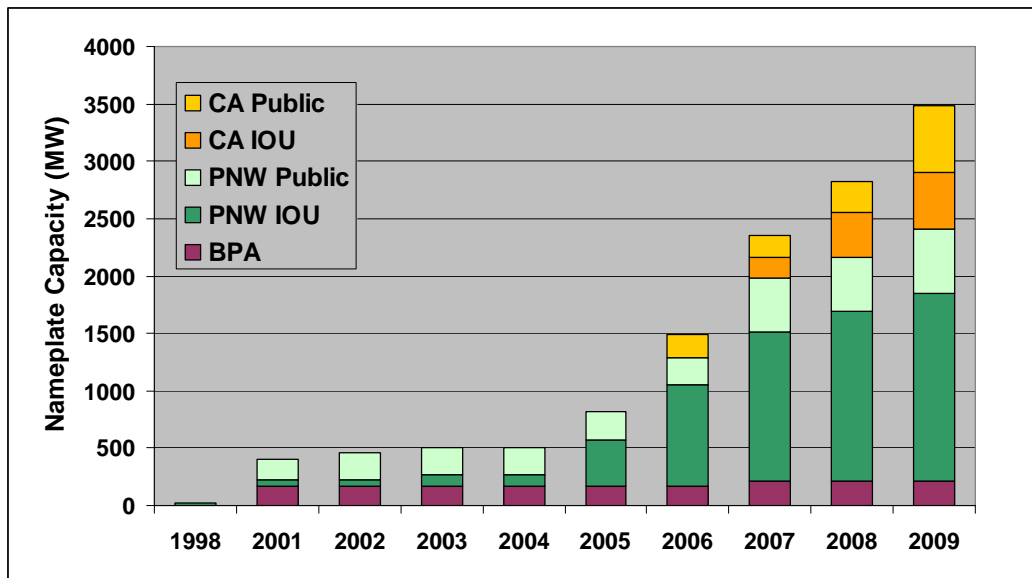


Figure 2: Wind capacity by customer type

Several thousand megawatts of additional wind generation are planned for development over the next several years. Over 1400 MW of nameplate capacity, in addition to that shown in Figures 1 and 2, is permitted, holds interconnection agreements and announced output contracts, and is scheduled for construction by 2012. BPA's generation interconnection queue has several thousand MW of additional generation seeking access to the system in the 2010-2013 timeframe. Because regional wind generation development has outpaced regional energy requirements and renewable energy required by Northwest renewable portfolio standards, the pace of development may ease in the next several years. High construction costs, financing constraints resulting from the economic recession and increasing concern regarding the budgetary impact of the federal production tax credit may also act to delay development in the near-term. Over the longer-term, escalating state renewable portfolio standard benchmarks and increasingly aggressive state and federal greenhouse gas control policies will likely keep demand for wind power high.

### **System operations**

One effect of the recent rapid development of wind power has been that many regional system operators are now working with substantial amounts of wind and developing a better understanding of the operational dynamics of wind projects. In general, the basic findings of the Action Plan have been ratified, e.g. wind has a relatively modest impact on incremental regulation requirements, but increases the demand for within-hour load following capability more substantially. On the BPA system, where much of the wind output is concentrated in one geographic region, system operators have also found that one of the greatest operational impacts is associated with hour-to-hour wind forecast errors, above and beyond the "within-hour" impacts. Short-term, unanticipated ramping events present the greatest challenges to reliable system operations. BPA's most recent forecast of the reserve requirements required to reliably integrate wind has increased relative to previous studies, partly due to the increasing amount of wind on the system, but also because of the increased reserve requirements associated with forecast inaccuracies. While there is a great deal of effort now underway to find ways to improve wind forecasts (and resulting schedules), this increase in reserve requirements has forced BPA to question whether it is possible to provide the necessary integration services for the thousands of additional megawatts of wind seeking interconnection to the BPA system beyond 2009. Integrating this amount of wind will likely require the ability to control wind output during extreme ramping events, improvements in wind scheduling accuracy, access to third-party supplies of generation inputs for the required integration services and development of a sub-hourly real-time market (the real-time market in the Pacific Northwest is currently a 60-minute market) to enable more frequent access to balancing energy supplies.

An increasing amount of wind scheduled for interconnection in the Northwest is also planned for ultimate delivery to California. To date, there has been very little coordination between Northwest and California parties on how to meet our combined requirements in the most cost-effective, reliable, and legally sustainable fashion possible.

### **Transmission**

Transmission concerns in the Action Plan are two-fold. One is the need to develop planning methods for transmission expected to primarily serve wind generation. Because the sustained peak capacity value of wind power was thought (and increasingly confirmed) to be low, it was believed that providing less-than-full transfer capacity would be more cost-effective than the conventional approach of providing full transfer capacity. Development of a transmission planning method to identify the optimal ratio of transfer capacity to installed wind capacity was identified as an important action. A second concern is the need to accelerate planning for new transmission to serve undeveloped remote wind resource areas as well as established wind resource areas with further growth potential. Importing wind energy from undeveloped, geographically diverse wind resource areas might reduce the net demand for system flexibility.

The Northwest transmission planning environment has significantly evolved since development of the Action Plan. The two Northwest transmission planning organizations, ColumbiaGrid and Northern Tier Transmission Group (NTTG), have matured and are deeply engaged in the WECC regional transmission planning and rating process<sup>1</sup>. Sponsors of several major transmission proposals potentially serving existing and new wind resource areas are well into the WECC Regional Planning Process and federal, state and local permitting efforts. As described below, the effort to develop new transmission planning methods for wind has progressed slowly, perhaps because of the view that wind power development is driven by available transmission capacity rather than the inverse. Planning for new transmission projects, however, has greatly advanced in the two years since the Action Plan was developed. Whether ambitious plans will mature into construction remains to be seen. From BPA's perspective, the increasing concentration of wind energy in the Lower Columbia raises the stakes for the planning and construction of transmission to new wind resource areas.

## **Status of the recommended actions**

**Action 1 - Assess the peaking capacity value of wind power:** Northwest wind project output during extreme weather events has typically been very low, suggesting that the earlier approach to rating capacity value, based on annual capacity factor, overstated the ability of wind power to serve peak loads. The concern was reflected in the provisional sustained peaking value of 15% initially adopted for wind by the Northwest Resource Adequacy Forum. Because few observations and little analysis underlay the 15% value, the task of confirming a value was identified in the Action Plan and charged to the Adequacy Forum. An initial study comparing wind output from a synthetic long-term hourly wind database to historical extreme weather events suggested sustained peaking values in the 15% range. However, subsequent comparisons using historical hourly wind output suggested much lower values. This, plus apparent weaknesses in the synthetic data, led the Adequacy Forum to reduce the sustained peaking value of wind to 5% for its 2008 system adequacy assessment. There remains a need to further confirm the 5% and to develop a credible long-term (60 - 70 year) synthetic hourly wind record to support LOLP reliability analysis using the GENESYS model and to complete the work of Action 14b (see below). A provisional 40-year synthetic wind dataset has been developed by BPA by sampling and splicing of historical records. A longer-term (1929+) hourly temperature-correlated wind output dataset is being developed by Portland State University under contract with BPA. This dataset will be available in six months to a year. Creation of a synthetic long-term dataset using mesoscale modeling is also being explored. The Council and the Adequacy Forum are supporting this effort, however completion is expected require another year.

**Action 2 - Refine assessments of the cost and availability of existing wind integration capability:** As the Action Plan was under development, four regional utilities (Avista, Idaho Power, PacifiCorp and Puget Sound Energy) plus BPA had completed or were developing assessments of wind integration capability and cost. The results of these assessments lead to the Action Plan's conclusion that no fundamental technical barriers existed to operationally integrating the 6,000 MW of wind called for in the

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<sup>1</sup> The WECC Regional Planning Project Review (Regional Planning Process) is intended to provide stakeholders the opportunity to participate in or review proposed transmission projects, to avoid duplicate projects and to allow integration of others needs. The Regional Planning Process occurs during the Formation and Studies phases of project development. The Project Rating Review (Rating Review Process) is intended to ensure that a new project is rated while protecting the ratings of other facilities. The Rating Review Process occurs in three phases: a Proposed Rating developed during the Formation and Study phases of development, a Planned Rating, developed during the Studies and Licensing phases of development and an Accepted Rating developed during the Licensing and Construction Phases of development. The Progress Reports process is intended to report potential additions and changes to the existing system and to provide WECC members the opportunity to comments on these proposals. Progress reports are required throughout the development and construction process.

Council's Fifth Power Plan (although the wind was assumed to be spread across the region, with BPA integrating 50%, or 3,000 MW, of the planned resource). The estimated cost of integrating wind energy provided by the individual utilities varied from \$2 to \$16 per MWh, depending upon wind penetration, the assumed market price of power and the utility's portfolio of resources and balancing authority size. These conclusions were viewed as preliminary and the Action Plan recommended that the existing assessments be refined and assessments be undertaken by additional balancing authorities. Since then, BPA, Idaho Power and Avista have refined their integration studies. Also, an integration study has recently been released by Portland General Electric. This work has narrowed the range of estimated long-term integration cost to about \$5 - \$12/MWh of delivered wind energy, and has confirmed that sub-hourly wind following and generation imbalance constitute the major sources of the demand for system flexibility<sup>2</sup>.

This work has also confirmed the value of and immediate need for various, largely institutional, measures for improving access to existing regional integration capability, including ACE sharing, dynamic scheduling, improved wind forecasting, wind feathering during rapid up ramps and "fast" (sub-hourly) trading and scheduling. Further expansion, refinement and peer review of the various wind integration studies is desirable. Refinement of the studies is expected to continue, propelled by the needs of balancing authorities to justify cost recovery and the need of load-serving entities to accurately assess the cost of acquiring wind resources. The Forum could continue to support peer review and regional synthesis of study results as well as regularly-scheduled meetings to review operating experience and other regional wind integration developments. The Council is undertaking a regional synthesis of the results of these studies for its Sixth Power Plan and intends to cite in that plan the actions needed to fully utilize existing regional integration capability.

**Action 3 - Develop wind resource data:** Relatively recent development of commercial scale wind projects in the Northwest and the limited amount of publicly available information regarding the operation of these projects lead the Wind Integration Forum to conclude that existing wind data is inadequate to fully quantify the benefits of cooperative operational strategies or geographic diversification, to inform transmission planning efforts, and to fully evaluate the capacity value of wind. To remedy this situation, the Forum recommended the development of a synthetic high-resolution chronological Northwest wind dataset. Funding for this data set was provided by BPA and the U.S. DOE (through the National Renewable Energy Laboratory (NREL)) in early 2007. Development of a two kilometer cell, ten-minute, four-state, five elevation wind speed dataset for years 2004 - 2006 was completed in October 2007. The database was subsequently expanded to include forecasted wind turbine output for 30,000 data cells. The dataset has been transferred to NREL for permanent hosting. The data is currently available on request and a web-based interface for public access is expected to be operational in November 2008.

**Actions 4 and 5 - Develop and apply transmission planning methodologies:** The Forum's Transmission Planning subcommittee identified a need for improved planning methodologies for transmission improvements intended primarily to serve wind power. In particular, methodologies were needed to evaluate the tradeoff between providing capacity for the transfer of wind-generated energy and the value of energy lost at times of transmission congestion. This methodology would help determine the optimal level of investment in transmission intended to serve wind power development. Initial investigation of this issue by the Northwest Transmission Assessment Committee (NTAC) of the Northwest Power Pool lead to the recommendation for these actions. NTAC was called upon to complete

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<sup>2</sup> For Bonneville, down regulation capability at times of minimum load under minimum flow constraints is particularly constrained. These figures cover a range of utility sizes and wind penetration levels. BPA has indicated that its wind integration costs are strongly influenced by wind forecasting accuracy and as a result, NW wind developers are working actively to improve their scheduling/forecasting accuracy.

development of the methodology (Action 4); however, in recognition that aspects of Northwest transmission planning would be shifting to the newly organized ColumbiaGrid and Northern Tier Transmission Group (NTTG), Columbia Grid and NTTG were called up to “convene a joint session” to begin applying the methodology (Action 5). The NTAC work on these actions ceased shortly following the adoption of the Action Plan, and essentially no subsequent progress has been made on this action. This lack of progress may be attributable to the shift of technical transmission planning from the nascent regional efforts of NTAC to individual organizations promoting specific transmission projects; to the evolving roles of ColumbiaGrid and NTTG as regional clearinghouses for assessing potentially competing transmission proposals; or, to implicit recognition that wind development is largely reactive to transmission development and that decisions regarding the optimal level of wind capacity on a given transmission circuit will be made with respect to the level of wind development rather than the level of transmission service. Even though the proposed planning approach may not be necessary for the engineering of new transmission, it appears to remain relevant for assessing available wind power transfer capacity on a line once built and for cost-benefit assessment of transmission proposals intended to serve wind projects. However, no “champion” for this work has stepped forward.

**Action 6 - Remove regulatory barriers to more efficient use of transmission for wind and other renewable resource development:** Utilities have historically procured long-term firm transmission for the full output of their generation facilities to ensure energy delivery at times of system peak loads. Since wind is primarily an energy resource, with little contribution to meeting system peak loads, guaranteed delivery in all situations is not required. Consequently, the Action Plan proposed a transmission model that seeks the optimal balance between new transmission investment and the value of delivered wind energy. This would be achieved through mechanisms such as conditional firm transmission service, reassignment of firm transmission rights, voluntary economic redispatch and the proposed planning method of Action 4. During development of the Action Plan, concerns were raised that state utility commission policies might not permit utilities to fully pursue this objective because of risk allocation issues. For this reason, the Action Plan called upon the state commissions to review and commence to amend as necessary, regulatory policies to remove barriers to more efficient use of transmission for wind and other renewable resources, achieving consistency between the states where feasible.

The Oregon Public Utility Commission (OPUC) assumed the lead in executing this action. The Commission held a wind integration workshop in May 2007. Workshop participants concluded that there is no fixed regulatory requirement that a utility acquire firm transmission for the full output of a wind farm. A utility can propose, and Commissions, in general, can approve alternative transmission arrangements, including the use of conditional firm transmission. Public utility commissions typically have discretion to weigh, on a case-by-case basis, the higher costs of using firm transmission for the full output of a wind farm against the delivery risk of using conditional firm transmission. Although there is a much broader set of outstanding cost-recovery and cost-allocation issues associated with transmission development, in the wake of the OPUC workshop (and another regulatory forum in Santa Fe in the fall of 2007), it does not appear that there is anything inherent to the current regulatory paradigm that prevents utilities from making more active use of conditional firm transmission service if they can present a compelling business case for cost recovery.

**Action 7 - Greater utilization of the transmission system:** This Action Item tasked BPA with undertaking several initiatives to explore greater utilization of the transmission system and to share the results with other regional transmission providers. Much of the BPA-centric work is complete. BPA has developed and implemented a redispatch platform to purchase incremental and decremental capacity from market participants in order to alleviate congestion on transmission paths on the BPA system. The effort began by involving federal and non-federal generators within the BPA balancing authority and is now being expanded to include generators outside of the BPA balancing authority. The effort has helped

reduce the number of curtailments across the BPA system and on the interties to California. As part of FERC Order 890, BPA agreed to remove the price cap on reassignments of transmission capacity, an initiative designed by FERC to promote greater liquidity in the secondary market for transmission and to promote greater utilization of existing Available Transmission Capacity (ATC). BPA has also adopted FERC's proposal for Conditional Firm Transmission Service (CFTS) and will begin offering the service to customers in March 2009. BPA expects to deploy CFTS as a bridge product in its Network Open Season until new transmission capacity is built to accommodate all of the requests that participated in the process. All three of these efforts have been communicated to stakeholders throughout the region and there may be possibilities for more widespread adoption of regional redispatch mechanisms over the longer term.

**Action 8 - Planning for expansion of transmission capacity on BPA's system:** Load growth, conventional generating resource development and continued wind power development east of the Cascades are likely to require reinforcement of portions of the BPA transmission system including the McNary - John Day corridor, the I-5 corridor from Paul substation (near Centralia, WA) to the Portland area and possibly the north and south Cross-Cascades corridors. Because of growing congestion in these corridors and the prospects of continued wind power development east of the Cascades, the Action Plan recommended completion of plans of service for reinforcing these corridors with priority given to the West of McNary and I-5 Corridor projects.

*West of McNary:* A draft planning report for the proposed West of McNary Project was released by BPA in June 2007. The WECC Regional Planning Review process was initiated by ColumbiaGrid in June 2007 and the report was sent to WECC in January 2008. WECC accepted the report in February 2008. The WECC Phase I rating process is underway under the auspices of the WECC Technical Study Coordination Group.

*I-5 Corridor:* A draft planning report for the proposed I-5 Corridor Project was released by BPA in June 2007. The WECC Regional Planning Review process was initiated by ColumbiaGrid in June 2007 and the report was sent to WECC in January 2008. WECC accepted the report in March 2008. The WECC Phase I rating process is underway.

*Cross-Cascades:* No activities regarding the North Cross-Cascades corridor have been reported. The proposed Southern Crossing project (see Action 10) would reinforce the South Cross-Cascades corridor.

**Action 9 - Financing expansion of transmission capacity on BPA's system:** The process of securing financial commitments to support transmission expansion on the BPA system has been handled through BPA's Network Open Season process and is now being evaluated according to BPA's new commercial infrastructure policy. BPA held an open season from April to June 2008 and secured 6,410 MW of signed Precedent Transmission Service Agreements. These agreements bind the signatories to take transmission service from BPA between requested points of delivery and receipt, contingent on BPA's ability to offer such service at its embedded cost rate and subject to completion of permitting required under the National Environmental Policy Act. Of the 6,410 MW of signed contracts, 76% were associated with wind energy projects. While there appears to be some geographical diversity implied by the requests, much of the participating capacity is still clustered in the general region of the Lower Columbia and Lower Snake Rivers. During the summer of 2008, BPA conducted a cluster study to determine the nature and cost of new transmission facilities required to accommodate all of the signed contracts. BPA will be conducting a financial analysis to determine if it has secured sufficient risk-adjusted revenue to justify financing and constructing additional transmission facilities and recovering the costs of such facilities at its embedded cost rates. The results of this financial analysis will be made public in early 2009.



**Action 10 - Planning for expanded capability for delivering wind power from Montana and other isolated wind resource areas:** Additional transmission may be desirable to expand wind development to currently isolated wind resource areas. Greater geographic diversity may increase the net sustained peaking capacity value of wind and reduce coincident ramps and other demands on system flexibility. Also, high plains wind resource areas are, in general, more productive than Lower Columbia areas and may provide better seasonal coincidence with energy market values. Expanded access to remote wind resource areas may become necessary to meet state renewable portfolio standard benchmarks and to access low CO<sub>2</sub> resources to achieve state, regional and potential federal greenhouse gas reduction goals. Proposals that could improve access to the prime wind resources of Montana and other wind resource areas include the PacifiCorp Gateway West project, the NorthWestern Energy Mountain States Transmission Intertie (MSTI), the Idaho Power Boardman to Hemmingway (B2H) project, the TransCanada Northern Lights proposal and the Montana-Alberta Transmission Intertie. Gateway West, B2H and Northern Lights sponsors have completed Phase I of the WECC three-phase rating process. NorthWestern submitted the MSTI Phase I comprehensive report in March 2008 and has initiated the Phase II process. Recently, the investor-owned utility Colstrip participants have announced discussions to explore opening up additional wind resources in Montana by upgrading the Colstrip Transmission System (CTS). BPA has recently joined with the CTS participants to explore upgrading its portion of the CTS. Expansion of transmission capacity into Harney County in southern Oregon is also being evaluated as part of BPA's Network Open Season process. Individually and as a group, these transmission projects would provide substantial expansion of transfer capacity from remote wind resource areas. We anticipate that as the proposals mature, there will be ongoing discussions between regional parties about the potential for additional joint participation, planning coordination, and joint financing.

Significant analytical efforts focused on transmission expansion have also been initiated by the Western Electric Industry Leaders Group (WEIL) and the Western Governor's Association. The WEIL Group contracted with energy consultancy E3 to conduct a study of the costs and benefits of inter-regional transmission expansion across the West. And the Western Renewable Energy Zone effort sponsored by WGA is intending to identify needed transmission lines to open up access to renewable resource rich areas in the west. Both of these efforts have implications for Northwestern transmission development and merit further attention by Northwestern parties.

**Action 11: Evaluate benefits of a regional wind forecasting network:** Improved near-term forecasting of wind production and improved integration of forecast results into power system operations can reduce wind integration costs by reducing the need for wind-following capacity reserves. Preliminary BPA studies suggest that improving forecast accuracy from a two-hour persistence equivalent to a half-hour persistence equivalent could reduce the need for within-hour balancing capacity reserves by over 50 percent. A Northwest regional wind forecasting network has been proposed as a way to improve forecast accuracy. BPA's Wind Integration Team will begin work on this proposal in fall 2008 and discussions are underway with the wind community on how to implement short-term persistence forecasting in order to reduce the magnitude of the increase in BPA's 2010-2011 wind integration rate.

**Action 12: Implement ACE diversity interchange:** The 16 Northwest balancing authorities<sup>3</sup> are responsible for balancing their own loads and resources. As illustrated in Figures 1 and 2, however, the distribution of interconnected wind capacity is highly skewed to balancing authorities with coincident favorable wind resources and available transmission capacity. The impacts of wind integration on any one balancing authority can be reduced by sharing of flexibility resources and operational constraints. One aspect of the latter is Area Control Error (ACE) Diversity Interchange (ADI). Through ADI,

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<sup>3</sup> WECC has recently certified the NaturEner Glacier Wind Energy facility in northcentral Montana as a generation-only balancing authority, bringing the total number of balancing authorities in the Northwest to 17.

balancing authorities share ACE to reduce momentary generator movement by leveraging the diversity in their short-term load/resource balance. At the time the Action Plan was adopted, a group of four Northwest Power Pool balancing authorities, along with the British Columbia Transmission Corporation, were prepared to conduct an ADI pilot project. Action 12 called upon this group to provide a progress report to the Steering Committee upon completion of the pilot project. The pilot project was initiated in March 2007. Results were presented to the Technical Work Group at its July 2007 meeting. Based on the pilot project, benefits appeared to be considerably greater than costs and many important technical issues were clarified. Since the July 2007 meeting, 12 additional balancing authorities located in the Western Interconnection and directly interconnected with one or more existing ADI participants have executed the ADI Agreement. In addition, the WECC has requested its Operating Procedures Subcommittee to form a task force to perform a technical analysis of the impact of ADI in the Western Interconnection. In the meantime, the ADI Participants are involved in implementation efforts so that all 16 balancing authorities are using the ADI tool by January 2009. Although there are several technical issues that require resolution through the WECC, the Wind Integration Forum's Technical Work Group considers this to be an important and promising approach to reduce the impacts of wind integration and recommends vigorous support for ongoing efforts to establish a permanent ADI agreement across the region.

**Action 13 - Reduce barriers to marketing system flexibility:** One of the key findings of the Action Plan was that the region could not remain overly reliant on existing hydro resources to integrate its growing wind fleet. Rather, the report concluded (and it has subsequently become much more apparent given the accelerating growth rate of wind energy) that it is critical to develop mechanisms for better utilizing the flexibility of the region's thermal resources as well as developing new products, services and business practices for exchanging energy and capacity on a sub-hourly basis. Absent such mechanisms, BPA and other balancing authorities will be forced to carry unnecessary and uneconomic quantities of reserves in order to integrate wind projects, resulting in higher costs to consumers and lower overall wind integration capability. These conclusions are being reinforced throughout the West through forums such as the Western Governor's Association and the Committee for Regional Electric Power Cooperation (CREPC).

During 2007, a Forum sub-committee identified many of the technical and commercial barriers to faster and more active markets for flexibility products and services. It was noted, first of all, that there is considerable precedent for this type of commercial activity in the Northwest. For example, PowerEx is already an active seller of balancing capacity into the California ISO market, and Northwestern Energy has been purchasing regulating reserves from several sellers for the past few years. Recently, NaturEner, owner of the Glacier wind project in Montana, received approval to form a generation-only balancing authority, using contracted flexibility resources for integration. However, broader market liquidity has been undermined by a lack of standardized products and services for regulating reserves and other dynamic capacity products, limits on communication links between Balancing Authorities, and rigidities in transmission scheduling protocols and ATC calculations. Limitations on the dynamic scheduling capability of the Northern and Southern interties has also limited access to extra-regional flexibility. As a result of heightened regional awareness of the urgent need for such flexibility products and services, a joint initiative of NTTG, WestConnect and ColumbiaGrid has been created with the goals of identifying the business process changes required to enable sub-hourly energy and transmission scheduling and to get all of the Northwest balancing authorities technically enabled to exchange dynamic signals by early 2009. This is a promising initiative that needs to be resourced with key staff at participating utilities and closely monitored via regular progress reports to Northwest utility leaders.

In an effort that will likely accelerate greater commercial activity in the market for balancing services, BPA has conducted a Request for Information (RFI) for third party supplies of generation inputs to

support wind integration in its balancing authority. The agency received a robust response to this RFI and intends to enter into commercial negotiations with several participants in early 2009, with the hope of implementing demonstration projects in fiscal year 2010. We also note that during 2008, BCTC, BPA, Puget and Seattle City Light sponsored a study of the technical requirements associated with increasing the dynamic scheduling capability of the Northern Intertie. The study revealed some important initial findings, but needs sponsorship, and possibly funding, for a phase 2 analysis. Given the increasing demand for Northwest wind energy by California parties, a similar study to increase the dynamic scheduling capability of the Southern Intertie may also be merited. Fortunately, BPA and the California ISO have already initiated technical discussions focusing on wind forecasting, within-hour transmission schedule adjustments and other areas of mutual interest.

**Action 14.a - Assess options for augmenting system flexibility:** Does the addition of large amounts of wind generation to the Northwest power system create a specific need for additional flexible capacity? Or will sustained peaking capacity eventually needed to meet load growth, if properly chosen, provide sufficient flexibility for incremental regulation and wind-following needs? Answers to these questions continue to be debated.<sup>4</sup> However, to state that consideration of the ramping capability, or flexibility, of potential resource additions has recently risen in importance is not too rash. The primary objective of Action 14 is to identify and characterize resources that can provide *flexible* capacity to the power system. The Flexibility Augmentation Subcommittee met in December 2007 to discuss goals and objectives and a work plan. Progress on the work plan has been slow. Ongoing work aimed at extracting more load following capability from the existing system (Action 13) has been a more pressing topic in the industry. Some additional progress on the longer-term dimensions of this Action was made in October 2008, when the Wind Integration Forum sponsored a one-day Pumped Storage Hydro Workshop at the Council's central office. The workshop was well attended and participants learned that the ramping capabilities of pumped storage hydro are well suited to the integration of large amounts of wind generation. Long construction lead times and relatively high capital costs are potential drawbacks of pumped storage hydro. Further work on characterizing flexibility augmentation options is needed, with focus on the relationship of sustained peaking capacity needs for system reliability and rapid-response capacity for integrating wind. The Council is preparing a resource flexibility assessment for its Sixth Power Plan, but further assessment of this issue is likely to be needed. BPA's Technology Innovation R&D Program is also committed to exploring promising system flexibility options on both the supply and demand side. In general, there is a need for much better understanding of the need for flexibility solutions to accompany large-scale wind development. Possible options to raise such awareness in the regulatory and utility stakeholder community would be to hold a joint Commission hearing on the topic, to make flexibility augmentation the topic of an upcoming meeting of the Committee for Regional Electric Power Cooperation (CREPC) or to expand the scope of the Resource Adequacy Forum to include flexibility adequacy.

**Action 14.b - Assess tradeoffs between competing uses of system flexibility:** Because of the increasing value of hydro system flexibility for integrating wind energy, it is important to understand the impacts of possible further constraints on hydrosystem operations on the availability of flexibility from the hydro system. In recognition of this issue, the Council, in its Fifth Power Plan, called for an assessment of the effects of "shaping" (integrating) large amounts of wind power on other hydropower system operations. The Action Plan calls upon the Council to report these findings to the Forum, which may choose to pursue further analysis.

The Council has expanded the capability of its GENESYS system reliability model to model hourly wind project output. With hourly wind modeling capability available, the Council plans to assess the impact of

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<sup>4</sup> See: Kirby, Brendan and Michael Milligan, "An Examination of Capacity and Ramping Impacts of Wind Energy on Power Systems." The Electricity Journal, Vol. 21, Issue 7, Aug. /Sept. 2008. pp. 30-42.

increasing wind penetration on system performance. These assessments will include: (1) identifying the frequency and magnitude of overgeneration events resulting in spill or minimum flow violations; (2) identifying the point of potential failure to meet sustained peak loads; and, (3) assessing the frequency, magnitude and cost of non-hydro peaking resource operation. The impact of proposed changes to hydro system operation can then be assessed by comparing results of these assessments obtained using proposed system operating constraints with results obtained using current operational constraints.

Applying the GENESYS hourly wind modeling capability requires credible long-term hourly wind output data. The efforts described in Action 1 to extend the limited historical hourly wind output data are a prerequisite to completion of this action.

Hourly analytical capability cannot be used to assess sub-hourly system constraints or transmission impacts. Council staff intends to identify possible sources of analytical capability for assessing sub-hourly impacts.

### **Action 15 - Develop a planning framework for maximizing the value of wind energy**

BPA has raised concerns that coincident ramping potential resulting from continued clustering of wind projects in the Lower Columbia area will soon result in unsustainable demands on system flexibility. To help resolve this issue, the region must determine the economic tradeoffs between integration costs, busbar costs and transmission expansion; and then develop a regional transmission plan that results in a wind development pattern that optimizes among these cost variables. The Action Plan calls on the Council to initiate this process by demonstrating this planning framework in its next power plan. The Sixth Power Plan, scheduled for release for public comment in May 2009, will include an initial effort to develop the wind planning framework called for in this action. This effort will include a reconnaissance-level comparison of the cost and energy yield of potential wind projects in Montana, Alberta, Wyoming and continued development of Lower Columbia Basin wind resources. Typical hourly wind profiles are being developed for each area using the high-resolution dataset of Action 3 for U.S. areas and historical hourly production records for Alberta. Preliminary analyses of the tradeoff between the marginal cost of transmission capacity and the marginal value of wind energy; the impact of geographic diversity on the net volatility of wind production, including frequency and magnitude of short-term ramping events; and the value, if any of co-locating system flexibility or storage resources at wind resource areas will be included. If promising, recommendations for further work will be provided in the action plan of the Sixth Power Plan. A broader discussion of this item, including the possibility of greater planning coordination on the topic between the Council and the region's transmission planning organizations, will occur at the December 2 Steering Committee meeting.

**Action 16 - Establish a Wind Integration Forum:** The Steering Committee called for the formation of a Northwest Wind Integration forum to monitor, facilitate and review implementation of actions called for in the Wind Integration Action Plan. In April 2007, the Forum was chartered as an advisory committee of the Council for a two-year period. During this time the Steering Committee was expected to meet once every six months to review and guide the work of a Core Analytical Team established to conduct technical analysis and provide analytical support to the organizations charged with implementing Action Plan items. The Core Analytical Team was to be comprised of technical staff from utilities, regulatory authorities, public interest organizations and others. In practice, one meeting of the Steering Committee has occurred since inception. The Core Analytical Team/Technical Work Group has met in May 2007, July 2007 and January 2008. The principal reasons for the Forum and its Technical Work Group meeting less frequently than expected lies largely with the unusually high level of activity in the industry over the past several years, perhaps coupled with the perception that the important tasks set forth in the Action Plan were being accomplished via *ad hoc* approaches. While substantial progress has been made on

several of the Action Plan actions, others, as evident in this status review, have not progressed as rapidly as desirable.

## Conclusions and recommendations

A summary of the status of the Wind Integration Action Plan actions is provided in Table 1. Where subsequent work has resulted in better definition of objectives, these “sub-actions” are listed individually below the original action. Though several actions have been completed without need for follow-on work, additional work is needed on most actions, either to complete the action as originally defined, or to implement needed follow-on activities.

The Steering Committee’s charter expires in April 2009 and the Committee must make a decision regarding the continued role, if any, of the Forum. Possibilities include:

***Issue final report and terminate Forum:*** Release this report as the final report of the Wind Integration Action Plan and allow the charter of the Steering Committee to expire. Further actions would be the responsibility of other organizations.

***Continue as a Forum for publicizing progress:*** Release this report as an interim progress report, with general recommendations regarding the purpose, objectives and priority of further actions. Extend the charter of the Forum for an additional two years. The Steering Committee would periodically convene for progress reviews and would release future progress reports.

***Continue the Forum in a more active role:*** Release this report as an interim progress report. Provide specific recommendations regarding the purpose, objectives, priority, schedule and responsibility for further actions. Extend the charter of the Steering Committee. The Steering Committee would periodically issue progress reports and convene for progress reviews. The Steering Committee might charge its Technical Work Group with the responsibility for undertaking a lead role in completing certain actions. Secure funding, as necessary for the accomplishment of certain actions. This was the original vision for the Forum.

In view of the continuing demand for new wind development in the Northwest and the pressing need for actions to accommodate that development in the most cost-effective manner while maintaining system reliability, the need for more aggressive and actively supported implementation of the Wind Integration Action Plan is evident.

**Table 1:** Summary of action status and recommended further efforts

	<b>Status</b>	<b>Recommended further efforts</b>
1. Assess capacity value:	Initial assessment complete; no identified obstacles to completion of follow-up work .	
a) Sustained peaking		Revisit capacity value when long-term hourly dataset is available (Reliability Forum)
b) Long-term hourly production		Complete long-term temperature-correlated hourly dataset (Reliability Forum) See 14.a.
2. Refine utility integration studies	Ongoing; periodic review and reporting needed, regional synthesis desirable.	Continue to refine and expand utility integration studies (Various) Suggest periodic review and best-practices assessment by Wind Integration Forum Technical Committee. Technical Committee can also be assembled to review operational experience and strategies from regional/national utilities and receive updates from BPA Wind Integration Team
3. High-resolution data base	In-progress; completion expected by end of 2008.	Complete web portal (NREL)
4. Develop transmission planning methodology for low capacity factor, variable resources	Stalled; redefinition of objectives and responsibilities may be desirable.	May be desirable for assessing available transmission capacity, for transmission cost-benefit studies or for further development of regional transmission plan (Action 15) Suggest joint analysis/review by NTTG/ColumbiaGrid.
5. Apply transmission planning methodology	See Action 4.	See Action 4
6. Regulatory policies	Complete	
7. Efficient use of transmission:	In progress; no identified obstacles to completion of action as defined. Other transmission utilities may wish to implement similar actions.	
a) Reassignments		
b) Conditional firm		
c) Economic redispatch		Opportunities exist to explore redispatch practices more broadly across the region. Suggest joint analysis./review by NTTG/ColumbiaGrid
d) Limit wind output to schedule; control ramp rates		BPA developing this capability jointly with wind community as part of work of agency’s Wind Integration Team. Other utilities may want to consider similar protocols.
e) Develop feed-forward AGC system		BPA developing this capability as part of work of agency’s Wind Integration Team. Other utilities may want to consider similar approach.

8. Transmission plans of service:	In progress; no identified obstacles to completion of action as defined. More specific definition of follow-on actions may be desirable.	
a) West of McNary		Continue with WECC 3-Phase planning & rating process (BPA).
b) I-5 Corridor		Continue with WECC 3-Phase planning & rating process (BPA).
c) Cross-Cascades North		Develop Plan of Service (BPA).
d) Cross-Cascades South		Continue WECC 3-Phase planning & rating process for Southern Crossing (PGE).
9. BPA transmission financing	In-progress; no identified obstacles to completion.	Complete commercial evaluation of participating requests in Network Open Season (BPA).
10. Transmission from remote wind resource areas	In-progress; further definition of follow-on actions may be desirable.	Continue development of proposals (PacifiCorp, NorthWestern, Idaho Power, Colstrip Partners, TransCanada)
11. Wind forecasting	Recently underway; no identified obstacles to completion.	Assess regional forecasting network and other approaches to improve wind forecasting (BPA WIT & others)
12. ACE diversity interchange:	Complete as defined; support of implementation needed.	
a) Complete pilot		
b) Implementation		Finalize permanent ADI agreement; expand participation. Resolve outstanding issues at WECC.
13. Flexibility markets:	Underway; further definition of scope, objectives deliverables and responsibility for sub-actions may be desirable	
a) Develop sub-hourly transmission scheduling capability		Ratify specific deliverables and personnel resources for successful implementation of NTTG/WestConnect/ColumbiaGrid Joint Initiative objectives. Institute periodic reporting to Steering Committee and other forums.
b) Develop ability for all NWPP balancing authorities to dynamically schedule across interchange points		Work underway through NTTG/WestConnect/ColumbiaGrid Joint Initiative. See previous entry.
c) Access 3 <sup>rd</sup> party supplies of generation inputs (BPA)		Commence commercial negotiations with implementation of demonstration projects in time for FY2010. (BPA)
d) Expand dynamic scheduling limits across Northern intertie		Establish sponsoring organization and possibly funding for Phase 2 study.

14a) Flexibility augmentation options	Recently underway; further definition of objectives desirable.	Assess need for incremental flexibility in addition to incremental sustained peaking capacity. Presentation on flexibility augmentation at joint Commission hearing or CREPC meeting may be desirable.
14b) Tradeoffs between competing uses of flexibility	Holding, pending development of data from Action 1.	Initiate assessments when long-term hourly data is available (Council).
15. Planning framework to address tradeoffs between busbar costs, concentrated wind development, and transmission expansion	Recently underway for Sixth Power Plan. Follow-on actions expected to be required.	Complete initial framework for the 6th Power Plan. If promising, identify additional work in the 6th Plan Action Plan (Council) Consider planning coordination on the topic between the Council and the region's transmission planning organizations
16. Charter Wind Integration Forum; periodic meetings Steering Committee & Technical Work Group	In progress	Decision required regarding future role of the Forum (Forum).



# Status of the Northwest Wind Integration Action Plan

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# Some terminology



- **System flexibility:** The ability of supply or demand side resources to quickly respond to changes and uncertainties in system conditions. In PNW, typically provided by rapid-response capacity such as hydro.
- **Balancing Authority (BA):** An electric system bounded by metering and capable of controlling generation to maintain its interchange schedule and contributing to frequency regulation of the interconnection. Also known as Control Areas. 17 in the PNW.
- **Area Control Error (ACE):** A measurement of load-resource balance via frequency and interchange metering.
- **Dynamic scheduling:** Electronic transfer between interconnected BA's of time-varying electricity consumption or generation so that balancing resources in one BA can be used to balance loads or generation in another BA

“The Council, working with Bonneville, utilities, SBC administrators, applicable state agencies, the wind industry other stakeholders will convene a forum to develop a strategic plan ...” Action 8A of the Fifth Power Plan

- Fifth Power Plan called for 5000 MW of new wind by early 2020s
- Action 8A of the Plan called for a Wind Confirmation Plan
- By 2006 it was evident that pace of wind development was far more rapid than anticipated in Fifth Plan
- Bonneville & Council formed a Wind Integration Policy Steering Committee in summer of 2006.
- A Technical Working Group met from summer 2006 through spring 2007 to assess regional wind integration potential and to identify needed actions to accommodate 6000 MW of wind development.
- Wind Integration Action Plan (WIAP) adopted by the Steering Committee March 2007.
- Wind Integration Forum was chartered by the Council April 2007.

# WIAP findings

No fundamental barriers to integrating 6000 MW of wind

The value of wind is to provide energy to displace fossil fuel consumption; other resources will be required to meet peak loads

Additional transmission capacity will be needed to achieve 6000 MW of wind and to open new areas to wind resource development to diversify production.

The major portion of wind integration costs are due to the need for additional flexibility resources to balance loads and resources to accommodate wind variability

Integration capability can be increased and cost lowered by:

- Spreading the variability of wind among balancing authorities

- Developing liquid markets for system flexibility

- Making more low-cost flexibility available from existing resources

- Developing new flexibility resources

# Principal WIAP Recommendations

- Assess peaking capacity value of wind
- Refine and expand studies of wind integration cost and capability
- Develop wind dataset for planning & analysis
- Develop and implement ability to plan and finance needed transmission
- Improve short-term wind forecasting
- Test ability to share area control error (ACE)
- Expand ability to market system flexibility
- Develop planning framework to optimize tradeoffs between transmission, wind quality, geographic diversity and cost of additional flexibility.

# Two years later we have learned ...

- Wind has low capacity value (5%); supplementary peaking capacity will eventually be needed, but will bring additional flexibility with it if properly chosen.
- Integration costs are lower than formerly estimated.
- Institutions have emerged to support transmission planning; financing mechanisms have been devised; numerous proposals for new transmission benefitting wind are being pursued.
- Improved short-term wind forecasting can greatly reduce the demand for system integration services.
- Low cost, largely institutional measures including control error sharing, dynamic scheduling, subhourly scheduling, and tapping third party flexible resources can extend the supply of system flexibility.
- Tradeoffs between transmission, wind resource diversity and quality and cost of new flexibility need to be better understood.

# Proposal for continued work I

- Extend charter of Wind Integration Forum (**Council**)
- Revitalize Technical Work Group, re-establish regular meetings and reporting (WIF).
- Fully implement area control error sharing (BAs)
- Explore feasibility and benefits of sub-hourly control area scheduling (WECC, BAs)
- Assess and implement appropriate upgrades to Southern and Northern Intertie dynamic scheduling limits (Owners)
- Establish dynamic scheduling capability across other PNW interchange points (BAs)
- Assess value of a regional wind forecasting network; implement if appropriate (WIF, BAs, wind owners)

# Proposal for continued work II

- Implement project to access 3<sup>rd</sup> party flexibility (BPA)
- Develop synthetic hourly wind dataset to complement long-term hydro and temperature (load) data (RAF)
- Complete & test ability for assessing flexibility/hydro constraint tradeoffs (Council)
- Evaluate the future demand for and supply of system flexibility on a regional basis (WIF)
- Identify the best options for extending system flexibility (Council)
- Complete framework for tradeoff assessment (Council), follow with in-depth assessment (WIF/NREL)
- Assess the nature and extent of the REC market with focus on the issues associated with REC “stripping” (Council?)



# Immediate next steps

- Complete paper setting forth next actions; secure approval of the WIF Policy Steering Committee (WP, EM, JK)
- Extend charter of the Wind Integration Forum (Council)
- Re-establish regular meetings and reporting of the Technical Work Group (Steering Committee)
- Ensure that all actions have a lead organization, workplan, adequate funding and personnel support (WIF/TWG)

# Transmission proposals serving Northwest wind resource areas

